Womanium Program 2024

# Classiq Certificate 1
# Implement a Multi-Control-X

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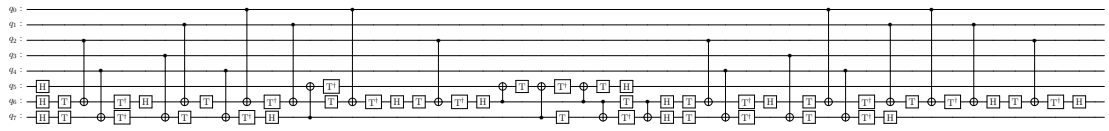
# 1 Task A

For the task at hand, three different implementations of an MCX (multi-control-X) with 5 control qubits and 1 target qubit were synthesized. Each implementation utilizes the control quantum operation for MCX.

The Task A.1 prioritizes minimal circuit depth, aiming to reduce computational steps. The Task A.2 focuses on minimizing circuit width, optimizing resource usage. The last task A.3 strikes a balance between width and depth, with parameters chosen to achieve an optimal compromise.

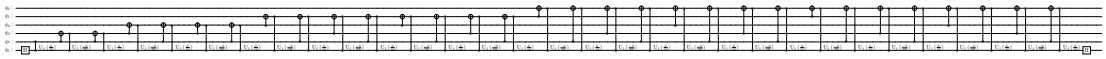
## 1.1 Task A.1

The following circuit is optimized for circuit depth. The minimum required depth to run the circuit on Classiq, considering the depth parameter, is 34 circuit depth units. Any depth less than this will not be supported by the platform. Achieving a depth of 34 requires a minimum of 8 qubits.



## 1.2 Task A.2

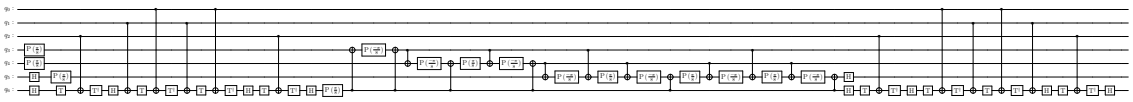
The following circuit is optimized for width. The minimum number of qubits required to run the circuit on Classiq, considering the width parameter, is at least 6 qubits. Any fewer qubits will not be supported by the platform. Running the circuit with a minimum of 6 qubits results in a circuit depth of 117.



## 1.3 Task A.3

The following circuit is optimized at the circuit depth and width levels. Finding a break-even point that optimizes both width and depth is essential. To determine this point, it was required to experiment with various values based on the results from Tasks A.1 and A.2.

Through this process, it was discovered that using 7 qubits with a depth of 51 achieved this break-even point.

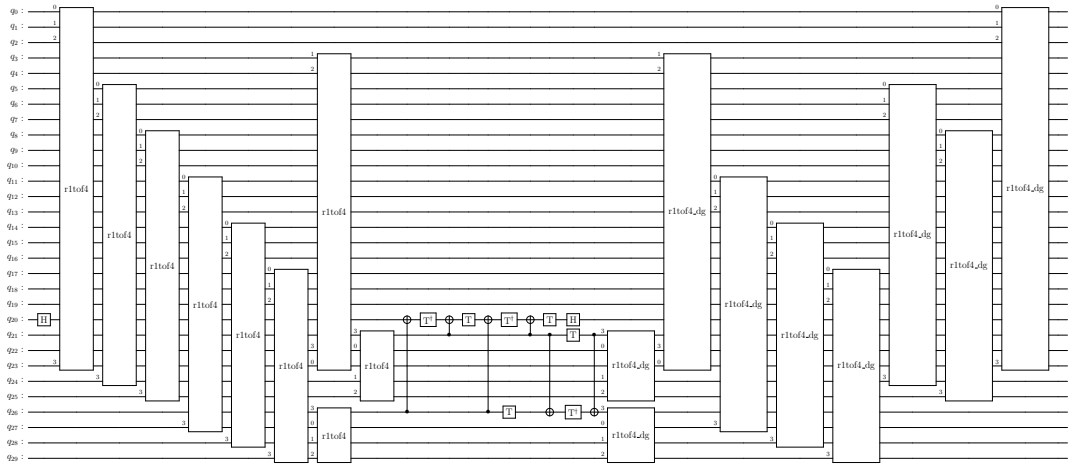


# 2 Task B

For this task was synthesized 2 different implementations of an MCX (multi-control-x) with 20 control qubits and 1 target qubit.

## 2.1 Task B.1

The following circuit is optimized for circuit depth. The minimum required depth to run the circuit on Classiq, considering the depth parameter, is 66 circuit depth units. Any depth less than this will not be supported by the platform. Achieving a depth of 66 requires a minimum of 30 qubits.



## 2.2 Task B.2

The following circuit is optimized for width. The minimum number of qubits required to run the circuit on Classiq, considering the width parameter, is at least 22 qubits. Any fewer qubits will not be supported by the platform. Running the circuit with a minimum of 22 qubits results in a circuit depth of 1894.

**Important Note** It was really complicated to show task B2' circuit for the depth of this cirquit. In case that you required the image in another format please let me know.

## 2.3 Task B.3

The following circuit is optimized at the circuit depth and width levels. Finding a break-even point that optimizes both width and depth is essential. To determine this point, it was required to experiment with various values based on the results from Tasks B.1 and B.2.

Through this process, it was discovered that using 27 qubits with a depth of 315 it was close to achieved a break-even point.